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(54) Abstract Title

Memory tag for a replaceable printer component

(57) A replaceable printing device component such as a toner cartridge 32 has a radio frequency identification (RFID) memory tag 36 with password protected data areas 48,50,58 to control read and write access to the memory tag 36. The printing device 30 is provided with an interrogator 45 which emits a radio frequency field which provides power to the memory tag 36 via the antenna coil 44. The memory tag 36 provides an encrypted authorisation code 52, which if the printing device 30 determines is valid, enables all the printing functions of the printing device 30. The memory tag 36 utilizes encryption methods to allow only authorised user access to read from or write to selected areas 48,50,58 of the memory tag 36.

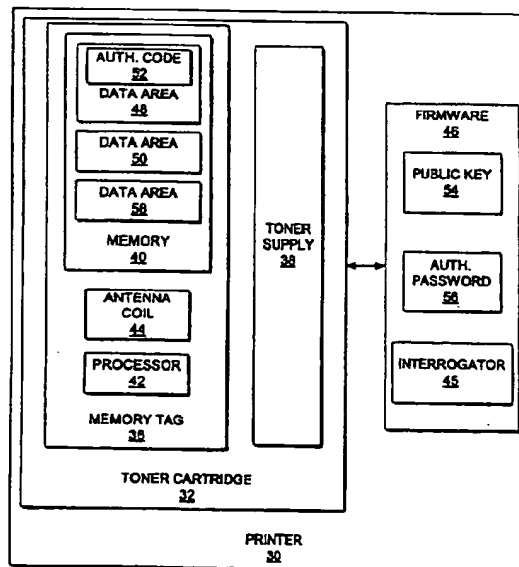


Fig. 3

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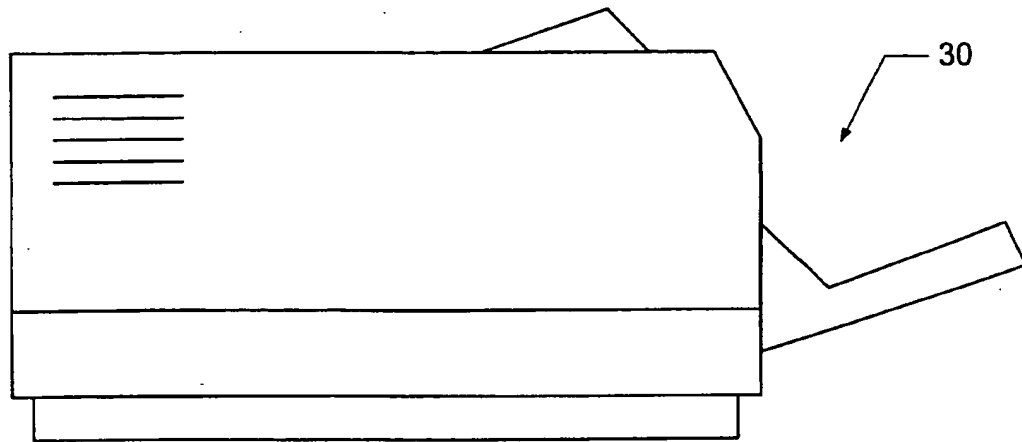


Fig. 1

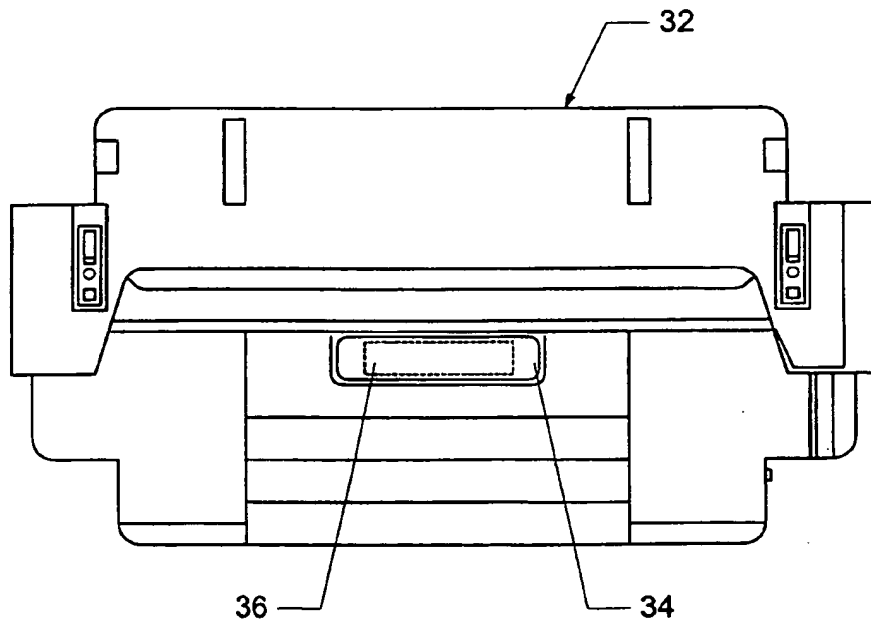


Fig. 2

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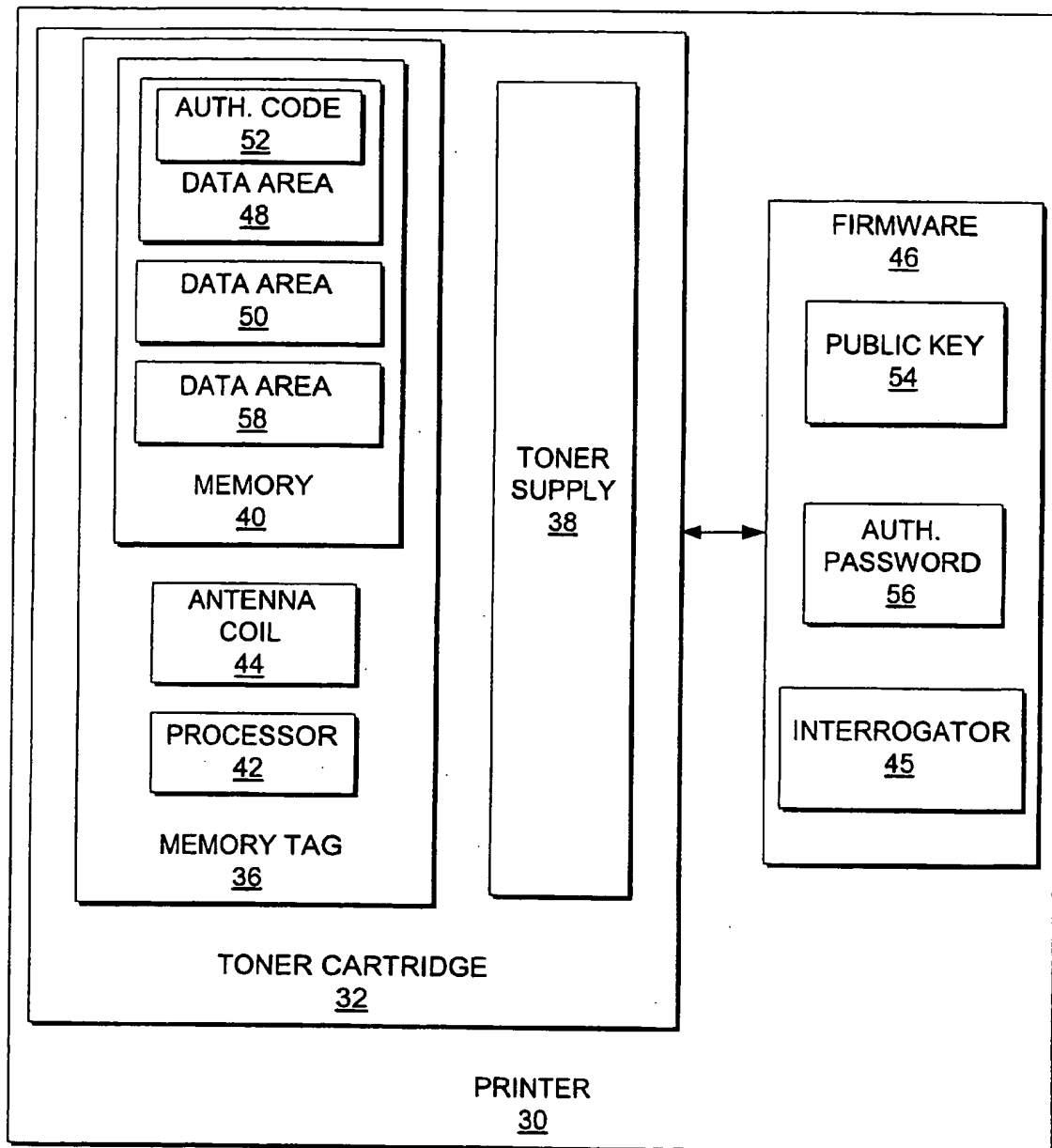
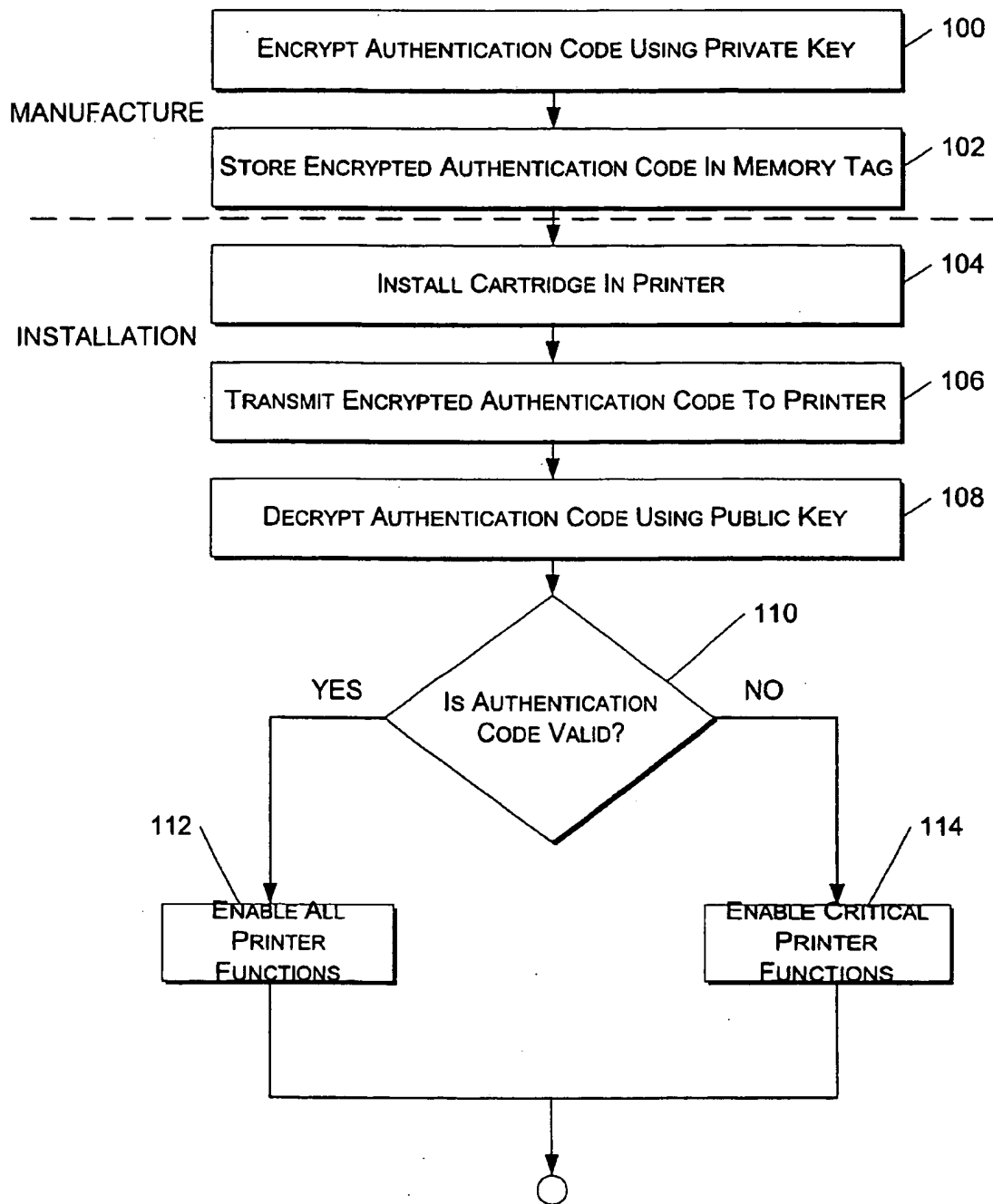


Fig. 3

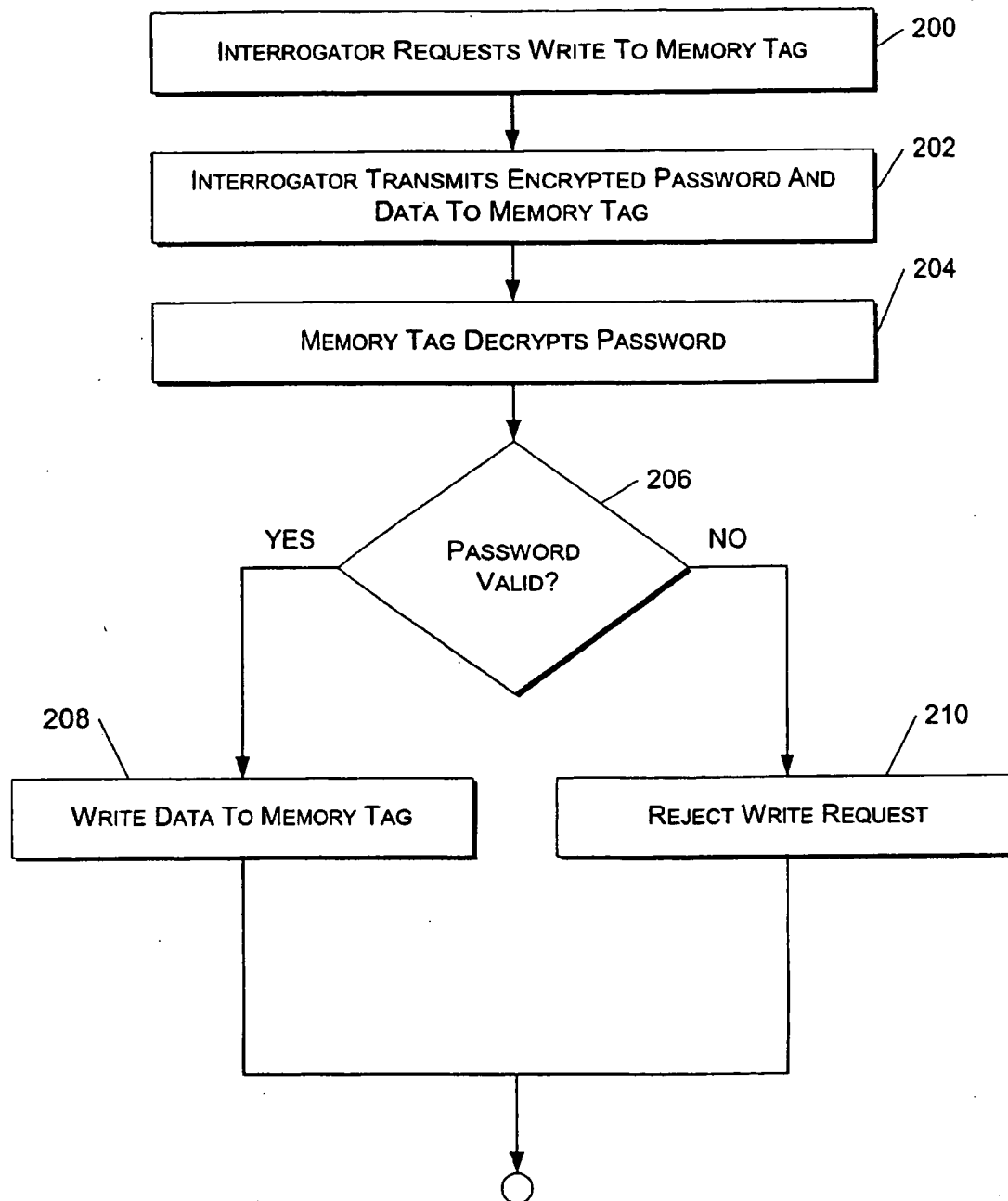
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AUTHENTICATION OF CARTRIDGE TO PRINTER

Fig. 4

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AUTHENTICATION OF INTERROGATOR TO CARTRIDGE

Fig. 5

1 Password Protected Memory On Replaceable

2 Components For Printing Devices

3
4 TECHNICAL FIELD

5 This invention generally relates to replaceable components installable
6 into printing devices, and more particularly, to printing device components
7 having a memory.

8
9 BACKGROUND

10 Several types of printing devices, such as printers, copiers, facsimile
11 machines, etc., have replaceable components installed in them that have a life
12 cycle during which the component is functional. When the functional life cycle
13 ends, the component is replaced with a new component. Examples of
14 replaceable components for printing devices include ink cartridges, toner
15 cartridges, ribbon cartridges, fusers, photoconductors, drums, and the like.

16 After a replaceable component has reached the end of its functional life
17 cycle, it can be recycled. For instance, when a toner supply within the toner
18 cartridge has been depleted, it can be refurbished by the original manufacturer
19 or by another toner cartridge vendor. Refurbishing a toner cartridge includes,
20 among other things, replenishing the toner supply. Preferably, the toner
21 cartridge is refilled with toner that conforms to the manufacturer's original
22 specifications so that the printing device will print properly and the refurbished
23 toner cartridge will have an acceptable life cycle. After a toner cartridge has
24 been refurbished, it can be resold for further use in a printing device.

25 Original equipment manufacturers (OEM) rely on trademarks and trade
dress to uniquely identify their products to consumers as being manufactured or
refurbished to original product specifications. A consumer is thereby assured

1 that he is purchasing a reliable component specifically manufactured or
2 refurbished for his printing device. By purchasing OEM components for a
3 printing device, the consumer is guaranteed that the component will conform to
4 manufacturer specifications, function as expected within the printing device,
5 and protect the printing device from sustaining damage.

6 Counterfeit refurbished printer cartridges pose a significant problem for
7 legitimate OEMs. For example, consider a laser printer that is manufactured
8 and sold by Hewlett-Packard. The laser printer originally contains a toner
9 cartridge that is manufactured by Hewlett-Packard or a certified OEM. When
10 the toner cartridge is depleted, the owner of the printer may choose to purchase
11 a toner cartridge from a company other than Hewlett-Packard and send in the
12 original cartridge to be refurbished. The vendor who receives the old toner
13 cartridge is now in possession of a toner cartridge that has been manufactured
14 by Hewlett-Packard and possesses all the outer markings of a genuine Hewlett-
15 Packard toner cartridge.

16 Hewlett-Packard does not exercise any control over the actions of the
17 vendor, who is free to refill the cartridge with any type of toner. The vendor
18 may refill the cartridge with a less expensive, inferior toner and resell the
19 cartridge as a genuine Hewlett-Packard toner cartridge. Also, the vendor may
20 not completely refill the toner cartridge with toner, giving the consumer much
21 less than the consumer has bargained for. To further enhance such a fraudulent
22 scheme, some counterfeit cartridge vendors have been known to actually
23 duplicate the packaging of the original manufacturer. The consumer – who
24 believes he has purchased a quality toner cartridge – actually receives an
25 inferior product that may not produce the print quality or print as many pages
as a genuine cartridge.

1 In addition, using inferior toner in a toner cartridge may also cause
2 damage to a consumer's printer. Not only does the consumer sustain damage
3 directly to his printer, the manufacturer of the printer may be harmed if the
4 consumer attempts to have the printer repaired under the manufacturer's
5 warranty on the printer.

6 Some printer cartridges are manufactured with memory integrated as
7 part of the cartridge itself or placed on the cartridge as part of the labeling.
8 This memory is used to store printer related data that the printer reads to
9 determine certain printing parameters and communicate information to the user.
10 For example, the memory may store the model number of the cartridge so that
11 the printer may recognize the cartridge as one which is compatible with that
12 particular printer. Additionally, by way of example, the cartridge memory may
13 store the number of pages that can be expected to be printed from the cartridge
14 during a life cycle, thereby allowing the printer to determine how many
15 additional pages may be printed by the cartridge.

16 This advancement in technology has not proven to stop counterfeit
17 cartridge vendors from trading on a manufacturer's earned reputation.
18 Information that would be stored in cartridge memory by a manufacturer is
19 simply stored by the vendor. For example, if the manufacturer places a code in
20 the cartridge memory to indicate that it has been refurbished by the
21 manufacturer, a counterfeit cartridge vendor can simply read the code from an
22 authentic cartridge and write the same code to each cartridge the vendor
23 refurbishes.

24 Utilizing read-only memory on printer cartridges is not a practical
25 solution to the problem because there are various types of vendors who
legitimately require write access to such memory. For example, a reseller may
need to access the memory to store a telephone number or a Universal

1 Resource Locator (URL) that would be provided to the consumer to assist in
2 ordering a replacement cartridge. Additionally, the printing device itself may
3 perform functions that require the device to write to the memory.

4 5 SUMMARY

6 The present invention contemplates encrypting data stored in memory
7 on a replaceable component of a printing device to prevent unauthorized access
8 to the memory. This will deter counterfeit cartridge vendors from having the
9 ability to read data from an authentic cartridge that could thereafter be stored in
10 the memory of a counterfeit cartridge. At the same time, authorized vendors
11 may have access to read the data.

12 A printer cartridge having memory containing an encrypted
13 authorization code provides the authorization code to a printer into which the
14 cartridge is installed. The printer is provided with a decryption key to decrypt
15 the authorization code. If the authorization code is valid, the printer enables all
16 its functions and operates normally. If the authorization code is invalid, the
17 printer enables only its basic print functions. Certain functions that depend on
18 the quality of the printer cartridge are disabled. For example, a printer may
19 have a function that tracks the number of pages printed from a printer cartridge
20 and estimates the number of pages that may be printed from the toner
21 remaining in the cartridge. Upon detection of an invalid authentication code,
22 the printer would disable this function as being unreliable since the function
23 would require the printer to know certain information about the cartridge and
24 the toner - e.g., how much toner was originally in the cartridge, how much
25 toner is used per page, etc. Because a counterfeit cartridge vendor may use an
inferior type of toner or only partially fill the cartridge with toner, it would be

1 impossible for the printer to have the information required for the function to
2 operate reliably.

3 The present invention also provides for password protection of portions
4 of cartridge memory, or data areas, so that only authorized entities having an
5 encryption key provided by the manufacturer can obtain read or write access to
6 certain portions of the memory. One or more data areas may be configured so
7 that any device may read from or write to the data areas. Other data areas may
8 be configured to allow all devices to read the data contained therein but would
9 require a device to present a password before being allowed to write to the data
10 areas. Still other data areas may be configured to require a device to have a
11 password or key before being allowed to read from or write to the data areas.

12 In the example of the reseller who needs write access to the memory to
13 store a URL for ordering a new cartridge, that reseller provides encrypted data
14 to the memory. Logic associated with the memory determines which area of
15 memory the reseller may access to store the information. The resellers
16 password allows access only to that specific area of the memory. The reseller
17 would not have the ability to read from or write to other areas of the memory to
18 which the reseller does not require access.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated by way of example and not limitation in the figures of the accompanying drawings. The same numbers are used throughout the figures to reference like components and/or features.

Fig. 1 is a diagrammatic illustration of a laser printer.

Fig. 2 is a diagrammatic illustration of a laser printer toner cartridge.

Fig. 3 is a block diagram of a printer.

Fig. 4 is a flow diagram of a cartridge to printer authentication process.

Fig. 5 is a flow diagram of an interrogator to cartridge authentication process.

DETAILED DESCRIPTION

Fig. 1 is a diagrammatic illustration of a laser printer 30 in which the present invention may be implemented. The invention may further be implemented in other units that employ printing devices, such as scanners, photocopiers, facsimile machines, and the like. For purposes of discussion, the invention is described in the context of laser printers.

Fig. 2 shows a toner cartridge 32 which is installable in the laser printer 30. The toner cartridge 32 has a label 34 which contains information identifying the toner cartridge 32 to a user. The label 34 typically recites the name of the manufacturer, the model number of the cartridge, etc. Although the invention is shown and described herein embodied as a printer toner cartridge for a laser printer, it is noted that the invention may be embodied as any replaceable component (toner cartridge, ink cartridge, fuser, drum, etc.) installable in a printing device (printer, copier, fax machine, etc.).

1 A memory tag 36 is located underneath the label 34 on the toner
2 cartridge 32, although it is understood that the memory tag 36 may be placed
3 on the toner cartridge 32 at any location which may be practical for the
4 purposes described herein. The memory tag 34 is preferably a radio frequency
5 identification (RFID) memory tag. RFID memory tags and applications
6 therefor are well known in the art. Further aspects of the RFID memory tag 36
7 structure and its functionality in the present invention will become more clear
8 as the discussion progresses.

9 Fig. 3 is a block diagram of printer 30 constructed in accordance with the
10 present invention. The printer 30 has the toner cartridge 32 installed therein
11 which may be removed and replaced by another toner cartridge (not shown). The
12 toner cartridge 32 includes a memory tag 36 and a toner supply 38.

13 As previously stated, the memory tag 36 is an RFID memory tag, although
14 it is noted that the memory tag 36 may be conventional semiconductor memory.
15 If, however, the memory tag 36 is semiconductor memory, some of the features
16 described herein will not function unless a logic unit is provided to operate in
17 conjunction with the semiconductor memory.

18 The RFID memory tag 36 has memory 40, a processor 42, and an antenna
19 coil 44. The RFID memory tag 36 is designed to operate in conjunction with an
20 interrogating device, also known as an interrogator. An interrogator is a device
21 that reads from or writes to the memory tag 36. Examples of interrogators
22 include a printer, a memory tag reader or scanner, a memory tag writing device
23 which stores data on the memory tag 36, and the like. In the present example, the
24 laser printer 30 includes an interrogator 45.

25 The interrogating device emits a radio frequency field which provides
power to the memory tag 36 via the antenna coil 44. The memory tag 36,

1 therefore, does not require its own power supply, a feature which adds to the cost
2 efficiency and practicality of utilizing RFID memory for the memory tag 36.

3 Communications between an interrogator and an RFID memory tag are
4 transmitted and received via the radio frequency field and the antenna coil 44
5 utilizing standard RFID method and protocol, as promulgated in ISO 14443 and
6 ISO 15693. Therefore, physical contact between the memory tag 36 and the
7 printer 30 is not required for the printer 30 to communicate with the memory tag
8 36.

9 RFID memory is particularly suited for the present application because
10 it does not require physical contact between the memory tag 36 and the
11 interrogating device. Additionally, RFID memory can be read from or written
12 to through many layers of packaging – up to several centimeters thick, a feature
13 that is particularly useful in the manufacture and marketing of toner cartridges.

14 The manufacturer may store certain data in the memory tag 36 when a
15 toner cartridge is manufactured. After the toner cartridges are manufactured,
16 they are packaged and marketed to resellers who distribute the toner cartridges
17 to retailers or to end users.

18 A reseller may wish to write information specific to the reseller to the
19 memory tag. For example, the reseller could store a URL in the memory tag so
20 that the end user will have convenient access to the reseller's ordering system
21 when the end user needs to order a new toner cartridge 32. If the toner
22 cartridge 32 is equipped with RFID memory, the reseller can store the URL in
23 the memory tag 36 directly through the toner cartridge packaging without
24 having to establish physical contact with the memory tag 36.

25 Utilization of RFID memory is also advantageous for worldwide
marketing of toner cartridges. A toner cartridge manufacturer may store certain
information in the memory tag 36, but may leave areas of the memory tag 36

1 available for later use by resellers. The toner cartridge 36 may be shipped to
2 another country which communicates in a language other than English.
3 Language-specific information, such as information that will be displayed to a
4 user, can be written to the memory tag 36 in the appropriate language. The
5 manufacturer is thus relieved of the burden of manufacturing special toner
6 cartridges for specific countries. Instead, the manufacturer can make a generic
7 toner cartridge and allow resellers to provide the more specific information to
8 the memory tag 36.

9 The toner cartridge 32 communicates with the printer 30 via firmware 46
10 resident within the printer 30. The firmware 46 is software which controls printer
11 functions and provides communication between the printer 30 and its
12 components, and between the printer 30 and the system (not shown) within which
13 the printer 30 operates.

14 The memory 40 has a data area 48 which contains encrypted data and a
15 data area 50 which contains unencrypted data. Data area 48 contains an
16 encrypted authorization code 52 which is utilized to authenticate the toner
17 cartridge 32 to the printer 30.

18 Fig. 4 depicts the process of authenticating the toner cartridge 32 to the
19 printer 30. The process has two phases: a manufacturing phase and an
20 installation phase. At the time of manufacture, the toner cartridge
21 manufacturer encrypts the authentication code 52 using a private key, *i.e.*, an
22 encryption code known only to the manufacturer (Step 100). For instance, a
23 manufacturer may encrypt the authentication code 52 using the well-known
24 RSA algorithm which employs a pair of public and private keys. Items
25 encrypted with the private key can be decrypted with the public key and vice
versa. At Step 102, the encrypted authentication code 52 is stored in data area
48 of the memory 40.

1 During the installation phase, the toner cartridge 32 is installed in the
2 printer 30 at Step 104 of Fig. 4. At this time, the authentication code 52 is
3 transmitted to the printer 30 from the memory tag 36 (Step 106). The firmware
4 42 in the printer 30 decrypts the authentication code 52 using a public key 54
5 which is provided by the printer manufacturer and is stored in the firmware 46.
6 The public key 54 corresponds to the private key used by the manufacturer to
7 encrypt the authentication code 52. The result is compared to an authentication
8 password 56 stored in the firmware 46 to determine the validity of the
9 authentication code 52, as shown in Step 110 of Fig. 4.

10 If the authentication code 52 is valid (i.e., the "yes" branch from Step
11 110), all the functions of the printer 30 are enabled (Step 112). If the
12 authentication code 52 is invalid (i.e., the "no" branch from Step 110), only
13 critical functions of the printer 30 are enabled (Step 114). The term critical
14 functions is determined by the printer manufacturer and can mean only those
15 functions necessary for the printer 30 to provide basic printing functions, or it
16 can mean any function that is not dependent on reliable information from the
17 toner cartridge 32. For example, the remaining page count function discussed
18 previously is not a critical function because the printer 30 may operate without
19 this function and because this function must receive reliable information from
20 the toner cartridge to provide accurate results.

21 Data area 50, which stores unencrypted data, can be read by any device
22 that can access the memory tag 36. Data area 50 may be write-protected so no
23 device can overwrite the contents stored therein, or it may be unprotected so
24 that a reseller may use data area 50 for purposes specific to the reseller, such as
25 to store a reseller's URL and make it available to a user.

Referring to Fig. 3, the memory 40 has an additional data area 58, which
contains data that may be encrypted or unencrypted. If the data contained in

1 data area 58 is unencrypted, then the data is readable by the public without the
2 use of a decryption key. If the data contained in data area 58 is encrypted, then
3 an entity desiring to read the data contained therein would first be required to
4 decrypt the data using a public decryption key made available by the
5 manufacturer.

6 It is noted that regardless of how a data area is configured for read
7 access, any data area may be configured so that only certain interrogators -
8 such as authorized resellers - can write to that particular data area.

9 Fig. 5 depicts a process for authenticating an interrogator to the toner
10 cartridge 32. At Step 200, the interrogator 45 requests to write to the memory
11 tag 36. At Step 202, the interrogator transmits a password to the memory tag
12 36 together with the data to be written to the memory tag 36. The password is
13 encrypted at the interrogator utilizing a public key distributed to authorized
14 interrogators by the toner cartridge manufacturer.

15 At Step 204, the microprocessor 42 of the memory tag 36 decrypts the
16 password using a private key stored in the memory tag 36 by the toner cartridge
17 manufacturer. At Step 206, the memory tag 36 determines if the password is
18 valid for a particular data area - either data area 50 or data area 58 - of the
19 memory tag 36. (It is assumed for this discussion that data area 48 contains an
20 authentication code 52 that cannot be overwritten).

21 The data is written to the memory tag 36 at Step 208 if the password is
22 valid. More specifically, if the password is valid for data area 50, the data is
23 written to data area 50. Similarly, if the password is valid for data area 58, the
24 data is written to data area 58. If the password is invalid, the write request is
25 rejected at Step 210.

Thus, a toner cartridge manufacturer may control access to different data
areas of the memory tag 36. One password may be provided for data area 50

1 and one password may be provided for data area 58. Additionally, another
2 password may be provided that allows access to both data area 50 and data area
3 58. If additional data areas are present, a password may be provided that
4 allows access to some, but not all, of the data areas, while another password
5 may be provided that allows access to all data areas.

6 Although the invention has been described in language specific to
7 structural features and/or methodological steps, it is to be understood that the
8 invention defined in the appended claims is not necessarily limited to the
9 specific features or steps described. Rather, the specific features and steps are
10 disclosed as preferred forms of implementing the claimed invention.

CLAIMS

1. A printing system comprising:
 - a printing device (30);
 - a replaceable component (32) installable in the printing device (32); and
 - a memory tag (36) affixed to the replaceable component (30), the memory tag (36) having at least one data area (48) which contains encrypted data.
2. The printing system recited in claim 1 wherein the data area (48) contains an encrypted authentication code (52) and the printing device (30) is configured to read and decrypt the authentication code (52).
3. The printing system recited in claim 1 wherein the memory tag (36) is radio frequency identification (RFID) memory.
4. The printing system recited in claim 1 wherein the replaceable component (32) is a toner cartridge.

1
2 5. A printing device component, comprising:

3 a memory tag (36) having first and second data areas (48, 50);

4 the first data area (48) containing encrypted data; and

5 the second data area (50) containing non-encrypted data.

6
7 6. The printing device component recited in claim 5 wherein the
8 first and second data areas (48, 50) are configured to be accessible by one or
9 more interrogating devices (45), and wherein the microprocessor (42) is
10 configured to utilize encrypted data received from the one or more
11 interrogating devices (45) to determine which data areas (48, 50) are accessible
12 by each interrogating device (45).
13

14
15 7. The printing device component recited in claim 5 wherein the
16 memory tag (36) is radio frequency identification (RFID) memory.
17

18
19 8. A method comprising:

20 receiving a replaceable component (32) into a printing device
21 (30), the replaceable component (32) having a memory tag (36) affixed
22 thereto, the memory tag (36) having at least one data area (48) which
23 contains encrypted tag data;

24 transmitting the encrypted tag data from the memory tag (36) to
25 the printing device (30); and

decrypting the tag data at the printing device (30).

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2 9. The method recited in claim 8 wherein the memory tag
3 (36) is radio frequency identification (RFID) memory and wherein the
4 encrypted data is transmitted from the memory tag (36) to the printing
5 device (30) without establishing physical contact between the memory
6 tag (36) and the printing device (30).
7

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9 10. The method recited in claim 8 wherein the encrypted tag
10 data is an authentication code (52) and wherein the method further
11 comprises utilizing the authentication code (52) within the printing
12 device (30) to determine which printing device functions to enable.
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11. A replaceable component for a printing device, comprising:
- a cartridge body;
 - a label affixed to the cartridge body; and
 - a memory tag having first and second data areas, the first data area containing encrypted data and the second data area containing non-encrypted data. --
12. The replaceable component as recited in claim 11 wherein the first data area of the memory tag contains an encrypted authentication code to identify the printing device component to an interrogating device. --
13. The replaceable component as recited in claim 11, further comprising a microprocessor to control access to the data areas of the memory by an interrogating device. --
14. The replaceable component as recited in claim 13 wherein the first and second data areas of the memory tag are configured to be accessible by one or more interrogating devices, and wherein the microprocessor is configured to utilize encrypted data received from the one or more interrogating devices to determine which data areas of the memory tag are accessible by each interrogating device. --
15. The printing device component recited in claim 13 wherein the microprocessor is located in the memory tag. --

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16. The replaceable component as recited in claim 11 wherein the memory tag is radio frequency identification (RFID) memory. --

17. The replaceable component as recited in claim 11, wherein the memory tag is located between the cartridge body and the label --.